

# **Bone Repair and Biomedical Engineering**

# Repairing Bones: Overview

- **Some serious breaks need the aid of engineers because:**
  - Need to restore function and position
  - Likely not to heal correctly
  - High risk of infection
  - Very long healing time
- **Biomedical engineers use internal and external fixation approaches**
- **While beneficial, added challenges and possible complications exist**

# Internal vs. External Fixation

- **Internal fixation:**

Temporary or permanent fixtures directly attached to the bone under the skin, for alignment and support

- pins
- rods or nails
- plates
- screws
- wires
- grafting

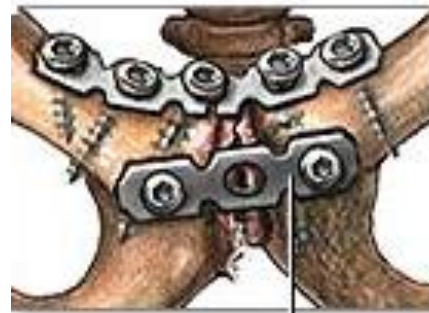
- **External fixation:**

Temporary repair supports outside of the skin that stabilize and align bone while the body heals

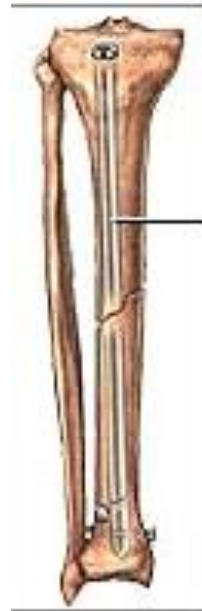
- screws in bone to hold in place
- metal braces or casts
- can be externally adjusted

# Internal Fixation

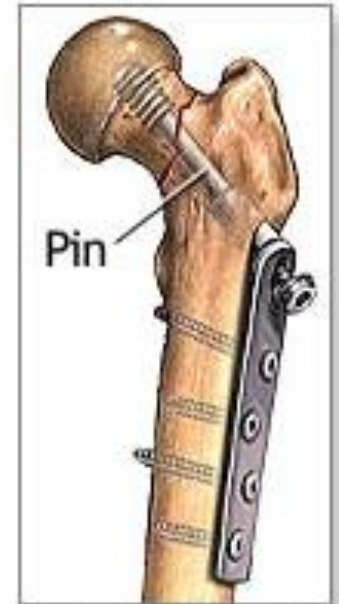
To determine the best repair technique, the break type and location are considered



Plate



Intra-medullary rod

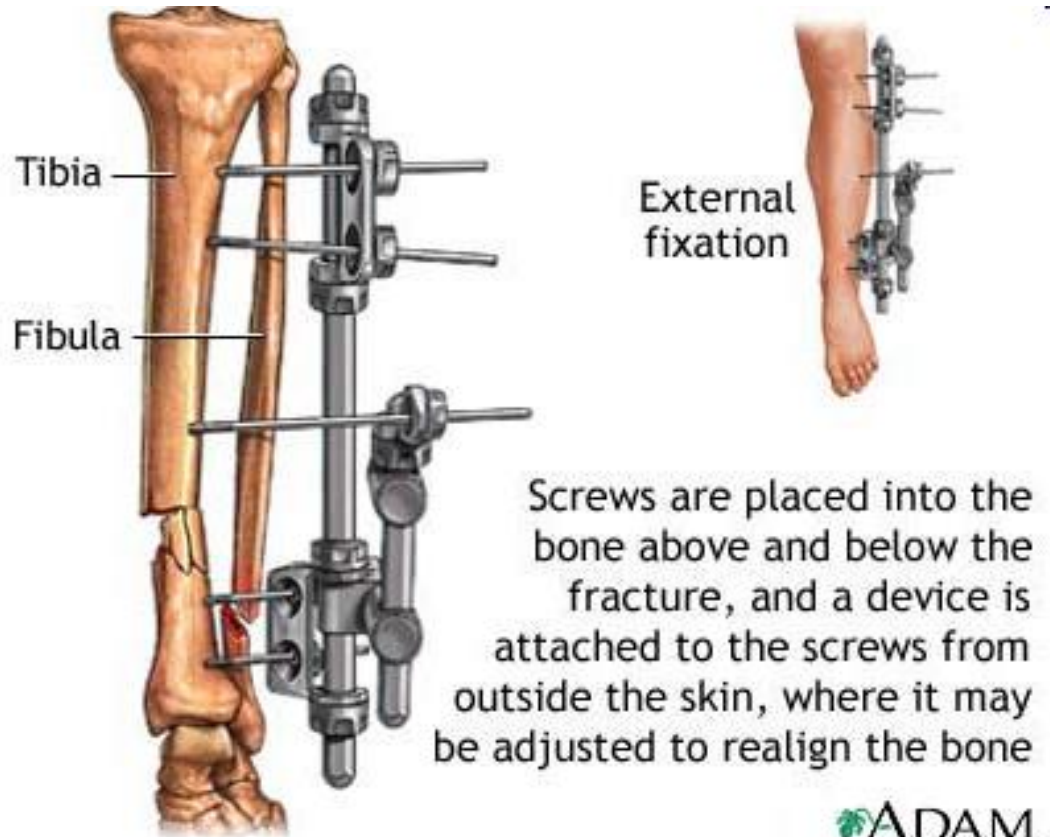


Pin

# External Fixation

Installing temporary repair supports outside of the skin to stabilize and align bone while the body heals.

**Examples:** screws in bone, metal braces, casts, slings.



# Example

## Spiral fracture-torsion break



**Tibia and fibula broken while skiing and repaired with a rod and pins.**



# Example: Rods, Plates and Screws

- **Rods** are used for alignment and support of long and large bones
- **Plates** hold together loose pieces of bone and support smaller bones
- **Screws** hold plates and rods in place

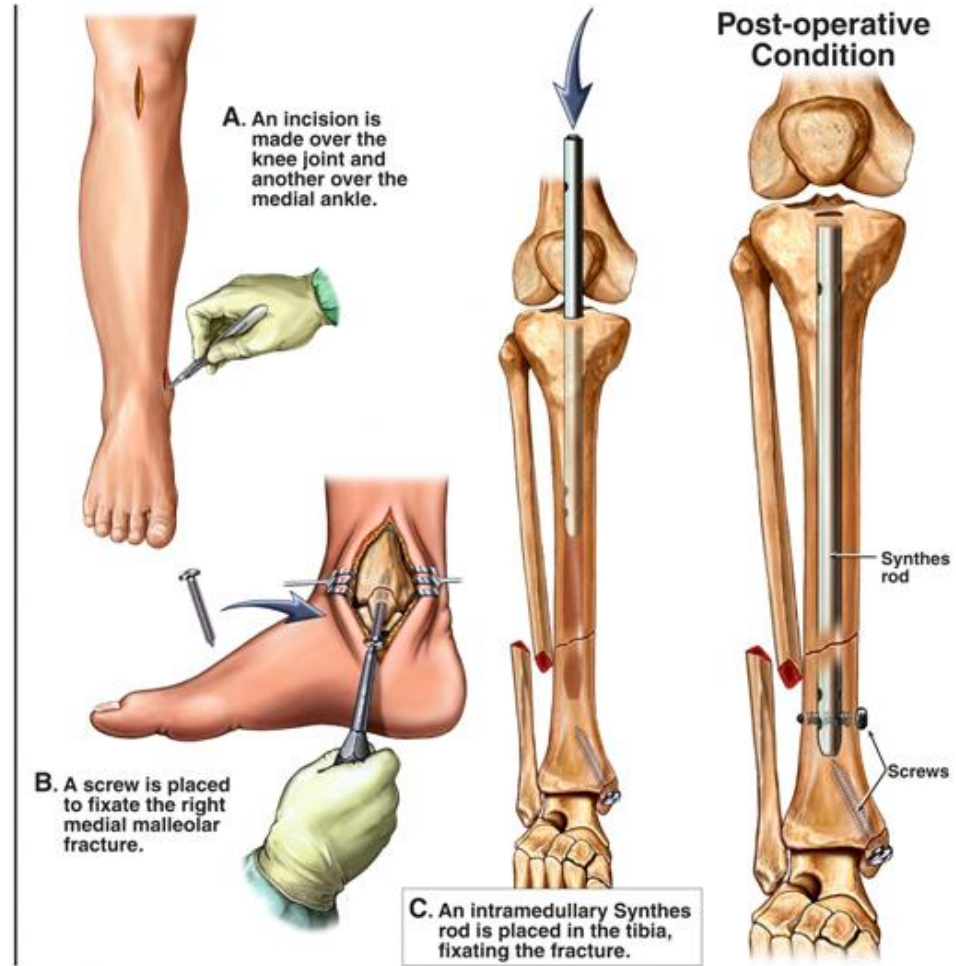




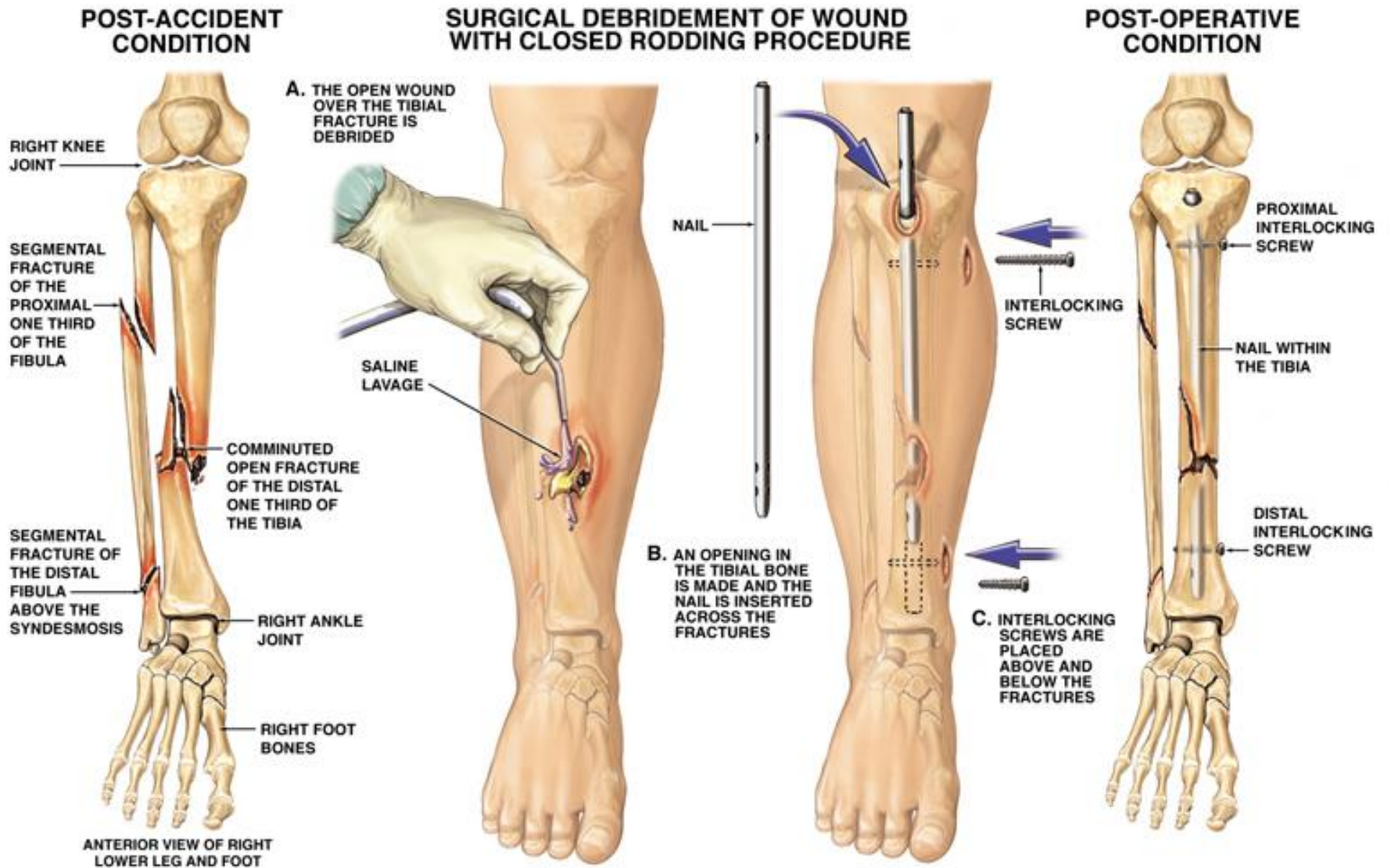
# Example: Rods, Screws and Pins



**Pins** are similar to screws and usually affix a detached piece of bone

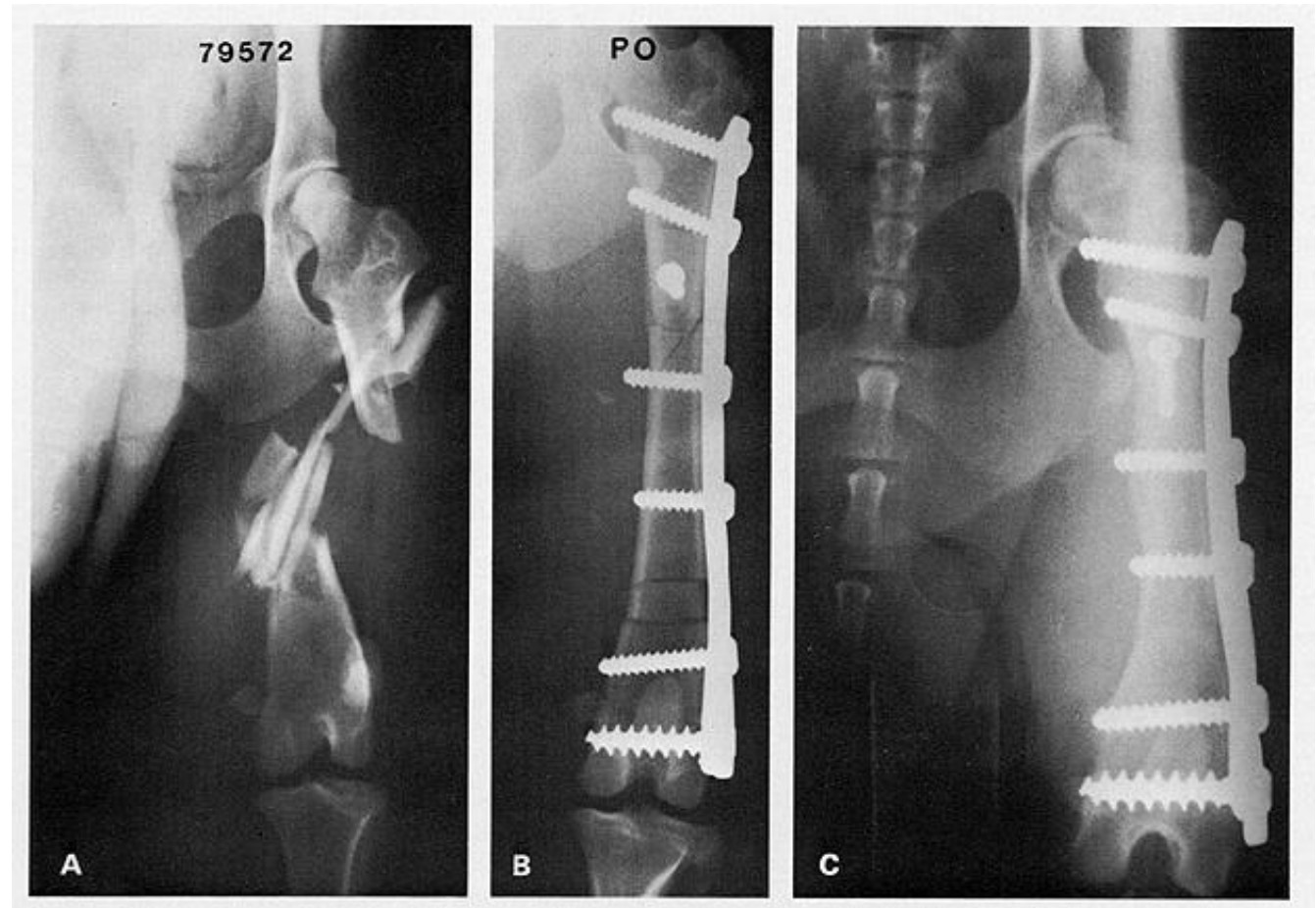






# More Plates and Screws

**X-ray example  
of shattered  
dog femur  
that was  
repaired with  
a plate and  
seven screws**



# Bone Grafting Example

Graft material is removed from patient's ilium (pelvis, hip) [left]

Bone graft fills a gap in a human spine [right]

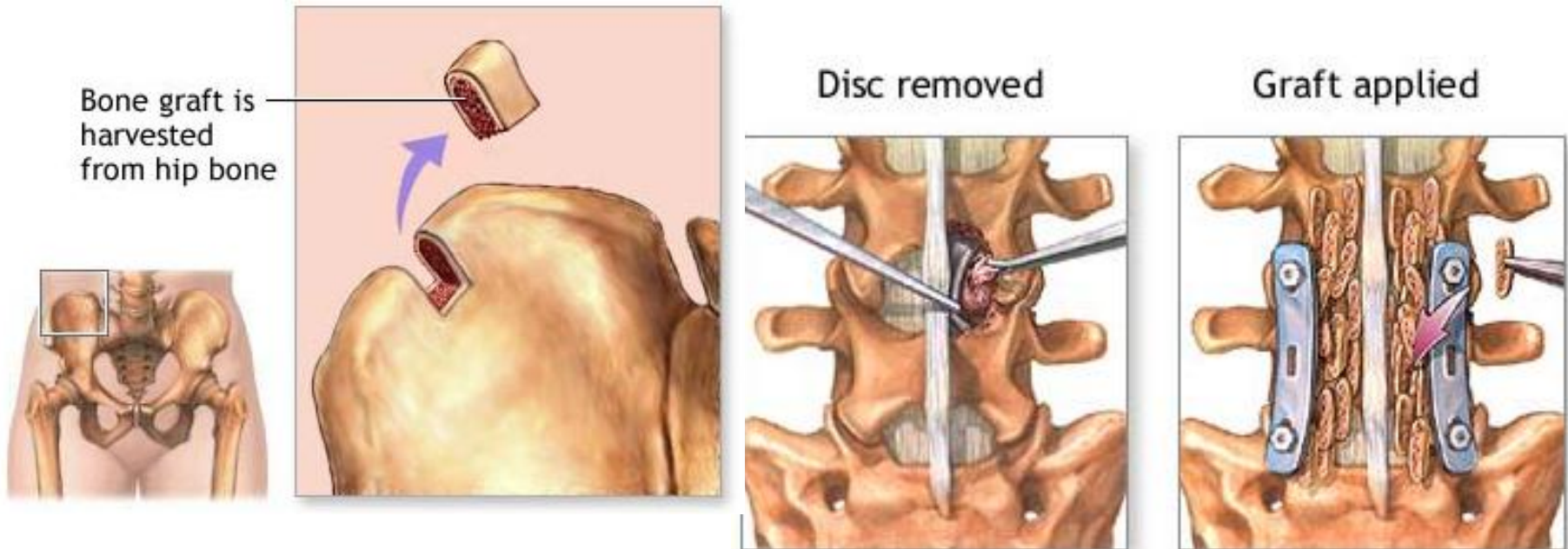


Image source: US National Library of Medicine, National Institutes of Health, MedlinePlus,  
(left) <http://www.nlm.nih.gov/medlineplus/ency/imagepages/8745.htm> and  
(right) [http://www.nlm.nih.gov/medlineplus/ency/presentations/100136\\_4.htm](http://www.nlm.nih.gov/medlineplus/ency/presentations/100136_4.htm)

# Medical Implant Materials

- Bone is an amazing material: **strong and flexible**
- Most human-made materials that are strong are also brittle
- To be accepted by the body and not cause other problems, the materials for rods, pins, screws and plates must also be **biocompatible**.
- Engineers design materials especially for medical implants that are made of:
  - Surgical stainless steels  
(blends of nickel, chrome and molybdenum)
  - Titanium alloys
  - Polymers





# Results

**After a few months, patients should be back on their feet, ready to participate in everyday activities**

Tibial intramedullary rod



ADAM.